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A TREATMENT FOR EDGE FACE OF PRESSURE-SENSITIVE ADHESIVE TAPES

*[Nen'chaku teipurui no sokumenshori houhoh]*

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*[There are no amendments to this patent.]*

## Specification

### 1. Title of the invention

A treatment for the edge face of pressure-sensitive adhesive tapes

### 2. Claim of the invention

(1) A treatment for the edge face of pressure-sensitive adhesive tapes characterized by the fact that an aqueous dispersion containing a crosslinkable photosensitizer and a wetting agent is coated onto the edge face of a tape having adhesion at the edge face such as pressure-sensitive

adhesive tape or self-stick tape, and light is applied to the above-mentioned coated surface so as to form a tack-free surface.

(2) A treatment for the edge face of a pressure-sensitive adhesive characterized by the fact that an aqueous dispersion containing a crosslinkable photosensitizer, a photoactive crosslinking agent, and a wetting agent is coated onto the edge face of a tape having adhesion on the edge face such as pressure-sensitive adhesive tape or self-stick tape, and light is applied to the above-mentioned coated surface to form a tack-free surface.

(3) A treatment for the edge face of pressure-sensitive adhesive tapes characterized by the fact that an aqueous dispersion containing a crosslinkable photosensitizer, vinyl base polymer compound, wetting agent, and an optional photoactive crosslinking agent is coated onto the edge face of a tape having adhesion on edge face, such as pressure-sensitive adhesive tape or self-stick tape, and light is applied to the above-mentioned coated surface so as to form a tack-free surface.

### **3. Detailed description of the invention**

The present invention pertains to a treatment for the edge face of a pressure-sensitive adhesive where crosslinking is performed for the edge face of a variety of tapes having adhesive on the edge face such as pressure-sensitive adhesive tapes and self-stick tapes to make the edge face tack-free.

Tapes such as pressure-sensitive adhesive tapes and self-stick tapes are commonly produced by coating a pressure-sensitive adhesive on a substrate film made of a material such as polyvinyl chloride, polyethylene, rubber, paper, cellophane, polyester or a fluoro resin, followed by drying and subsequently is wound on a cylindrical paper core, etc. Tension is applied at the time of winding, and in general, the film or sheet is wound in a stretched state.

Thus, pressure-sensitive adhesive tapes produced as described above experience a latent shrinkage force, and the force is applied from the outside wrap toward the center core, and, as a result, the pressure-sensitive adhesive on the pressure-sensitive adhesive tape is compressed and pressed outward toward the edges of the rolled tape and oozing occurs. As a result, dust adheres during storage and use, or blocking of rolls of tape occurs when rolls are stacked on top of each other [edge to edge].

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Furthermore, the over-lapped portion of the above-mentioned tapes at the edge forms a telescope-like shape due to the above-mentioned shrinkage force, resulting in a reduction in product value.

In an effort to eliminate the above-mentioned oozing of adhesive, a method whereby a coating solution such as a varnish or lacquer is applied to the edge face of the roll, and a method wherein a paper or plastic film is applied to the edge face to protect the edge face, etc. have been proposed in the past. Furthermore, as a means to prevent telescoping, many methods, for example, a method where the tape is supported by a metal reel, a core is inserted inside the cylindrical paper core, etc. so as to absorb the shrinkage force, have been proposed.

However, all of the above-mentioned conventional methods require additional process steps and extra materials, while adding cost; furthermore, when left standing at high temperatures, the above-mentioned oozing and telescoping continue to occur. Furthermore, conventional treatments for telescoping is complicated, and due to an additional equipment required, higher cost cannot be avoided.

Based on the above-mentioned background, a method consisting of coating the edge face of the adhesive tape with an organic solvent containing a crosslinkable photosensitizer, a crosslinkable photosensitizer and photoactive crosslinking agent, or a crosslinkable photosensitizer, photoactive crosslinking agent and a vinyl-based polymer compound and exposing the above-mentioned coated surface to an activating beam and crosslinking the pressure-sensitive adhesive or the pressure-sensitive adhesive and the polymer component included in the coating solution at or near the edge face of the tapes so as to form a cured layer and to form an edge face that is tack-free is proposed in Japanese Kokoku [Examined] Patent Application No. Sho 50-10353. According to the above-mentioned method, tack at the edge face is eliminated, and lateral shifting of the pressure-sensitive adhesive promoted by shrinkage of the tape can be prevented by the cured layer formed as a result of crosslinking, and oozing of adhesive and telescoping are blocked.

However, in the method proposed above, an organic solvent such as toluene, tetrahydrofuran, methyl ethyl ketone, or acetone is used as the medium for a coating solution containing a substance such as a crosslinkable photosensitizer, but the impact on the working environment and fire hazard pose problems, and further improvement is required from the standpoint of energy conservation as well.

Based on the above background, further studies were carried out by the present inventors and lead to the present invention; the present invention is a method for treating the edge face of a pressure-sensitive adhesive tape that is characterized by the fact that an aqueous dispersion containing (1) a crosslinkable photosensitizer and a wetting agent, (2) a crosslinkable photosensitizer, a photoactive crosslinking agent and a wetting agent or (3) a crosslinkable

photosensitizer, vinyl-based polymer compound, wetting agent, and an optional photoactive crosslinking agent is coated onto the edge face of a tape having adhesion at the edge face such as a pressure-sensitive adhesive tape or a self-stick tape, and light is applied to the above-mentioned coated surface to form a tack-free surface.

The above-mentioned photoactive crosslinking agent in this case means a material capable of eliminating active hydrogens included in the polymer upon exposure to an activating beam or a material capable of transmitting excitation energy from the excitation state to the active crosslinking agent and for example, benzophenone, 4-hydroxybenzophenone, 2-chloroanthraquinone, 2-methylanthraquinone, benzoylanthraquinone, anthranone, 1,4-naphthoquinone, 9,10-anthraquinone, 1,2-benzoanthraquinone, and other aromatic ketones, aromatic aldehydes, aromatic carboxylic acids, and furthermore, organic compounds containing a photosensitive halogen can be mentioned.

The amount of the above-mentioned component used is in a range of 0.01~1.0 wt% for the water content of the aqueous dispersion. When the amount used is less than 0.01 wt% the crosslinking rate based on application of light is reduced, and at the same time, the degree of crosslinking is not sufficient. On the other hand, when the amount of the component exceeds 10 wt%, it is not possible to maintain the aqueous dispersion in a stable state; furthermore, recoupling of the photoactive crosslinking agent is likely to occur or light transmittance is blocked, resulting in a reduction the curing rate and an increase in cost.

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The above-mentioned wetting agent is a material that imparts wettability to the edge face of the tape since adequate wettability does not exist for an edge face having low energy such as

the surface comprising the plastic film and pressure-sensitive adhesive layer, when the wetting agent is used, coating of the aqueous medium can be done easily; furthermore, a minimum amount of the aqueous medium is required.

For the above-mentioned wetting agent, those that belong to the surfactants group, for example, some polyethylene glycol alkyl ethers having a high surface tension such as alkyl benzene sodium sulfonates, dialkyl sodium succinates, and polyethylene glycol lauryl ether, can be mentioned. The amount of the above-mentioned component used is in the range of 0.05~5 wt% for the water included in the aqueous medium, and when the amount used is less than 0.05 wt%, adequate wettability cannot be achieved; on the other hand, when the amount exceeds 5 wt%, a reduction in the moisture resistance and adverse effects on the pressure-sensitive adhesive result.

As a means to increase the coatability of the aqueous dispersion on the edge face of the tape without using the above-mentioned wetting agent, a method whereby the viscosity of the aqueous dispersion can be mentioned, but when this method is used, control of the coating ratio is difficult; furthermore, when an excess amount is coated, the edge face as well as the tape surface are soiled and the initial function of the tape is likely to be lost.

The above-mentioned photoactive crosslinking agent is a material activated upon application of an excitation energy by an activating beam or sensitizer that initiates crosslinking of the vinyl-based polymer or copolymer included in the tape material or the pressure-sensitive adhesive or dispersion, and as a result of the increase in the crosslinking speed based on the above-mentioned crosslinking agent, the photon application time is reduced. For the above-mentioned photoactive crosslinking agent, N,N'-methylene bisacryl amide, ethylene glycol

dimethacrylate, polyethylene glycol dimethacrylate, 5-acryl amino-N-acryl caproamide, etc. can be mentioned. The amount of the above-mentioned component used is in the range of 0.5~20 wt%, preferably 1~10 wt%, for the water content in the aqueous dispersion, and when an excess amount is used, the crosslinking density becomes too high and flexibility is reduced as a result of excessive three-dimensional linking and cracking can result; on the other hand, when the amount used is insufficient, the target effect cannot be expected.

The above-mentioned vinyl-based polymer compound is added when the crosslinking speed of the pressure-sensitive adhesive tape or self-stick tape is slow, and crosslinking is less likely to be achieved due to rupturing, or a high edge face strength is required based on the type of tape used, etc., and when crosslinking of the pressure-sensitive adhesive tape or self-stick tape with the above-mentioned vinyl-based polymer compound, an increase in the crosslinking rate and an increase in the strength of the edge face can be achieved. For examples of the above-mentioned vinyl-based polymer compound, polyethylene, ethylene-vinyl acetate copolymer, acrylic acid-acrylate copolymer, etc. can be mentioned. The amount of the above-mentioned compound used is in the range of 1~30 wt% for the water in the aqueous dispersion. When the amount used is less than 1 wt%, an addition effect cannot be observed, and when the amount used exceeds 30 wt%, the increase in the coating layer blocks transmittance of light, the mutual crosslinking of the vinyl-based polymer compound added is promoted, and the degree of crosslinking of the pressure-sensitive adhesive tape or self-stick tape is not adequate.

The above-mentioned components in the aqueous dispersion containing the crosslinkable photosensitizer and photoactive crosslinking agent are dissolved in an organic solvent such as toluene, ethyl acetate, methyl ethyl ketone or xylene and added to water along with an



appropriate surfactant having an emulsification effect and dispersing is performed. Furthermore, a wetting agent is added to the vinyl-based polymer compound along with an optional dispersing coagent. As explained above, an aqueous dispersion containing (1) a crosslinkable photosensitizer and wetting agent, (2) a crosslinkable photosensitizer, a photoactive crosslinking agent and wetting agent, or (3) a crosslinkable photosensitizer, vinyl base polymer compound, wetting agent, and optional photoactive crosslinking agent is used in the present invention, and the combination of components is selected according to the pressure-sensitive adhesive used for tapes, ease in crosslinking of the pressure-sensitive adhesive tape or self-stick tape, and strength of the edge face.

For the source of the activating beam that initiates the above-mentioned crosslinking reaction, a xenon lamp, low-pressure mercury lamp, high-pressure mercury lamp, super-high pressure mercury lamp, sunlight, carbon arc lamp, etc. can be mentioned, and those having wavelengths in the range of 1,500  $\text{\AA}$ ~6,000  $\text{\AA}$ , preferably, in the range of 2,000  $\text{\AA}$ ~5,000  $\text{\AA}$ , can be used effectively. When the wavelength used is less than 1,500  $\text{\AA}$ , decomposition of the polymer component is likely to occur; on the other hand, when the wavelength exceeds 6,000  $\text{\AA}$ , sufficient energy for excitation of the photoactive crosslinking agent cannot be achieved.

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In general, light is applied for 16 seconds to 1 minute at 400 W from a high-pressure mercury lamp. The longer the light is applied and the greater the output of the light source, the greater the increase in the degree of crosslinking and the stronger the effect on prevention of oozing of the adhesive and telescoping.

The above-mentioned method where mutual crosslinking is carried out for the pressure-sensitive adhesive or the pressure-sensitive adhesive and the polymer added at the edge face of the tape is entirely different from conventional methods used, such as coating of the above-mentioned material onto the edge face of the tape and forming a tack-free layer. In other words, when crosslinking is performed, the very thin surface area of the pressure-sensitive adhesive at the edge face of the tape alone is hardened; thus, the surface appearance of the tape remains unchanged, the finish is clean, and furthermore, the hardened layer is chemically bonded to the pressure-sensitive adhesive polymer inside; thus, removal of the film as a result of impact is absent.

In recent years, heat and radiation have been used as energy sources for crosslinking standard polymers, but the method is not suitable for the purpose of the present invention, and the reason photo-energy is used in the present invention is explained below.

Thus, when thermal crosslinking is used, the crosslinking agent applied to the edge face of the tape does not remain at the edge face and the crosslinking agent undergoes diffusion and permeation, thus, when heat is applied, it is not possible to concentrate the energy at the surface alone and the heat is transmitted inside, and as a result, crosslinking of the pressure-sensitive adhesive inside takes place and the initial adhesion of the pressure-sensitive adhesive tape is reduced.

Meanwhile, when a radiation beam is used, crosslinking is promoted inside the pressure-sensitive adhesive due to the high penetration of the high energy beam; furthermore, the above-mentioned high energy beam is likely to reach the substrate and is likely to cause crosslinking of

the substrate; furthermore, a significantly higher cost is required for irradiation equipment safety and other safety features.

On the other hand, the energy penetration is low when crosslinking is done by application of light, the energy reaches only the surface area due to the low transmission of light energy, thus, crosslinking of the pressure-sensitive adhesive at the edge face of the tape alone can be achieved; furthermore, unlike the above-mentioned two methods, a simple equipment structure is required.

As explained in detail above, according to the method for edge face treatment of the pressure-sensitive adhesive of the present invention, it is possible to make the edge face tack-free without changing the surface appearance of the tape, and oozing of the adhesive and telescoping can be easily prevented using the simple method of applying light. And furthermore, the photoactive crosslinking agent, etc. is coated onto the edge face in the form of an aqueous dispersion; thus, unlike the case where an organic solvent is used, safe working conditions can be maintained in the production environment and there is no danger of fire; furthermore, the method contributes to energy conservation.

Furthermore, a wetting agent is included in the above-mentioned aqueous dispersion; thus, coating of the aqueous dispersion is easy, and the amount of the aqueous dispersion used can be controlled to a minimum; furthermore, the treatment conditions and cost advantage are increased, and a reduction in the product value as a result of contamination of the surface of the tape by excess coating solution is absent.

In the following, the present invention is explained in specific terms with Application Examples and Comparative Examples. It should be noted that the present invention is not

limited to these Application Examples and Comparative Examples.

#### Application Example 1

Coating was performed for both edge faces of a rolled of pressure-sensitive adhesive tape having a width of 19 mm and a length of 20 m produced by coating a pressure-sensitive adhesive made of a rubber-based polymer onto a support made of polyvinyl chloride with an aqueous dispersion produced by mixing 50 g of a 5 wt% toluene solution of 2-chloroanthraquinone, 3 wt% of polyethylene glycol alkyl phenyl ether (HLB 16), and 2 wt% of polyethylene glycol lauryl ether (HLB 14) and emulsifying at a high speed so as to form a coating weight on each side of 0.2 g, and a mercury lamp was applied from the distance of 10 cm for 20 seconds at an intensity of 400 W. As a result, adhesion on the edge face of the rolled tape was completely eliminated and when paper, etc. was brought into contact with the edge face, adhesion was absent. Furthermore, the initial properties of the tape remained the same as before the above-mentioned treatment.

#### Application Example 2

When a treatment was provided for a rolled pressure-sensitive adhesive tape with a width of 19 mm and length of 20 m produced by coating a pressure-sensitive adhesive made of a rubber-based polymer onto a support made of paper as in Application Example 1, the same good result was obtained.

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#### Application Example 3

Mixing was performed for a solution produced by mixing 43 g of toluene dissolved with 2 g of benzophenone and 5 g of tetraethylene glycol dimethacrylate and 50 g of a solution of 3

wt% of polyethylene glycol alkyl phenyl ether (HLB 16) and 2 wt% of dialkyl sodium sulfosuccinate and emulsification was done at a high speed and coating was performed for both edge faces of a rolled pressure-sensitive adhesive tape with a width of 19 mm and length of 20 m produced by coating a pressure-sensitive adhesive made of an acrylic-based polymer onto a support made of polyester using the above-mentioned aqueous dispersion so as to form a coating weight on each side of 0.2 g, and a mercury lamp was applied from a distance of 10 cm for 15 seconds at an intensity of 400 W. As a result, adhesion on the edge face of the rolled tape was completely eliminated and when paper, etc. was brought into contact with the edge face, adhesion was absent. Furthermore, the initial properties of the tape remained the same as before the treatment.

#### Application Example 4

Mixing was performed for a solution produced by mixing 50 g of a 5 wt% toluene solution of parachlorobenzaldehyde and 60 g of a solution containing 2 wt% of ethylene [sic] glycol alkyl phenyl ether (HLB 16) and 2 wt% of dodecyl benzene sodium sulfonate and emulsifying at a high speed, then, 10 g of an aqueous dispersion containing 40 wt% of ethylene-vinyl acetate copolymer having a vinyl acetate content of 45 wt% was added to the above-mentioned mixture and coating was performed for both edge faces of a rolled pressure-sensitive adhesive tape with a width of 19 mm and length of 10 m produced by coating a self-stick tape made of a mixture of butyl rubber and polyethylene with the above-mentioned aqueous dispersion so as to form a coating ratio on each side of 0.2 g, and a mercury lamp was applied from a distance of 10 cm for 20 seconds at an intensity of 400 W. As a result, adhesion on the

edge face of the rolled tape was completely eliminated and when paper, etc. was brought into contact with the edge face, adhesion was absent. Furthermore, the initial properties of the tape remained the same as before the above-mentioned treatment.

#### Comparative Example 1

Coating was performed for both edge faces of a rolled pressure-sensitive adhesive tape described in Application Example 1 with an ethyl acetate solution containing 20 wt% of a vinyl chloride-vinyl acetate copolymer having a vinyl acetate content of 30 wt%, and drying was subsequently done at a temperature of 80°C for 5 minutes. The properties of the above-mentioned rolled tape were the same as those of the tape before the treatment, but a slight degree of tack on the edge face was observed.

#### Comparative Example 2

A vinyl chloride film with a thickness of 50  $\mu$ m and having the same shape and size as the edge face of the rolled pressure-sensitive adhesive tape described in Application Example 1 were applied to both edge faces of the rolled tape.

50 rolls each of the pressure-sensitive adhesive tape treated according to the method described in the Application Examples above and Comparative Examples 1 and 2 and each of the tapes used in the Application Examples without the above-mentioned treatments were used as samples and the three different tests (A)~(C) explained below were performed after storing the samples in an air-conditioned room kept at a temperature of 40°C for 2 months and the results obtained are shown in the Table below. The numbers in the table are the number of samples regarded as being defective.

## (A) Stacking test

10 rolls each of the tape were stacked and packaged, then stored in the above-mentioned air-conditioned room. Defective in this case means tapes that stuck to one another and for which removal was difficult.

## (B) Paper peel test

A thin paper was applied to both edge faces of the samples and the samples were stored in the above-mentioned air-conditioned room. Defective in this case means a tape where the pressure-sensitive adhesive on the edge face stuck to the thin paper and made it difficult to remove the paper.

## (C) Telescoping phenomenon test

Each rolled tape was stored individually in the above-mentioned air-conditioned room. Defective in this case means a tape where protrusion of the edge face exceeds 3 mm after storage.

Table

Test method		Sample									
		App Ex 1		App Ex 2		App Ex 3		App Ex 4		Comp Ex 1	Comp Ex 1
		N-T	T	N-T	T	N-T	T	N-T	T		
Number of defective pieces	A	48	0	47	0	46	0	28	0	29	0
	B	50	0	50	1	48	0	48	0	39	4
	C	37	2	2	0	20	1	7	0	25	26

Note) In the above-mentioned Table, "N-T" indicates non-treated tape and "T" indicates treated tape.

As shown in the Table, according to the treatment for the edge face of the present invention, telescoping when rolled tapes are stored under a high temperature for an extended time can be effectively prevented. On the other hand, when coated film (Comparative Example 1) is

used, the above-mentioned problem remains unsolved, and when paper is applied, oozing of adhesive can be prevented but telescoping remains unsolved.

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